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INFRASTRUCTURE INVESTMENT AND INFLATION IN SAUDI ARABIA*

ROBERT E. LOONEY(**)

ABSTRACT: Since the 1973/74 oil price increases, Saudi Arabia has embarked a major program of infrastructure expansion. The purpose of this program is to alleviate the many bottlenecks hindering increases in the country's non-oil productive sectors. The purpose of this paper is to examine the effectiveness of the country's infrastructure program. In particular has the Saudi Arabian government's investment program been successful in reducing inflationary pressures and hence in creating an environment conducive to sustained expansion of the non--oil private sector economy? On the other hand, has the government's massive investment in infrastructure simply created an additional inflationary source of aggregate demand for the kingdom's scarce domestic resources?

The main findings of the study are that the country's infrastructure led growth has been successful in achieving its main aim: the reduction in structural sources of inflationary pressures in the non-oil sectors. In this respect, the government's strategy began paying fairly respectable growth rates, even during periods of slack oil revenues. It still remains to be see however if past infrastructure investments will be able to sustain the growth momentum built up in the late 1970s and early 1980s.

INTRODUCTION

The possibility that the resulting supply side effects of public sector investment in infrastructure can reduce inflationary pressures has long intrigued

(*) *Final version: November 1989.*

(**) *Robert E. Looney is Professor, National Security Affairs, Naval Postgraduate School, Monterey, USA.*

economists. Tersely put, increases in investment in infrastructure, while perhaps inflationary in the initial construction stage, may ultimately result in reductions in the price level through the elimination of bottlenecks and the resulting increase in the supply of goods and services. In particular, investment in such areas as transportation and energy, thereby reducing the costs of commercial production, appear to have the potential of being particularly effective in this regard. It follows that if a stable relationship between increases in infrastructure and reductions in the cost of production exist, the public sector in many developing countries would have a powerful tool at its disposal to achieve high growth with only limited inflationary pressures. Investment in infrastructure, therefore is seen by its advocates as creating a wide spectrum of newly profitable areas of investment for the private sector. This phenomenon has been stressed by Hirschman (1958) in his unbalanced growth strategy. Perhaps even more importantly , infrastructure's contribution to price stabilization in most likely to result in a shifting of investment from short run inflation hedges to longer run capacity increasing forms of asset accumulation. The net result should *ceteris paribus* result in a higher over all long growth rate.

Interestingly enough, despite the compelling attractiveness of the infrastructure led development strategy, no country case studies had, until quite recently (1) been undertaken to determine its effectiveness in reducing domestic inflationary pressures. Because it has both the willingness and the means to undertake a program of infrastructure led development , Saudi Arabia provides an ideal case study for examining the effectiveness of a development strategy built on massive increases in infrastructure (Loonely, R.E. and Frederiksen, P.C. 1985). Not only is the government committed to a strong ideology of free market capitalism stressing development of private enterprise, but has by design maintained and supported a policy of encouraging the private sector to take advantage of the profitable opportunities opened up by public sector investment. This policy package includes business freedom, low taxes,

(1) J. Barkley Rosser, Jr., 1983. Unfortunately Rosser's study does however have several limitations: he uses the consumer price index, which includes mainly price controlled staple goods, and his measurement of infrastructure is proxied by Real Estate Development Fund and Agricultural Loan Bank loans, both of which contain a high precentage of subsidy payments. These subsidies are not necessarily associated in any regular manner with the construction of fixed capital (infrastructure) assets.

low tariffs, no national debt, relatively stable prices, an elaborate industrial subsidy program (subsidized loans, low fees for industrial estates etc.), minimum restrictions on the inflow of capital and emigrants. With the notable exception of petroleum, a few oil-related industries, and certain manufacturing activities planned by the government and financed by state oil revenues, all traditional economic activities are privately-owned and operated (Amuzegar, J., 1974).

In terms of their commitment, the Saudi authorities have spent more on infrastructure in the last fifteen years than any country in history over a similar time period. Since 1970 when the country initiated its first development plan, the government with the completion of the Third Plan in 1985 had allocated approximately 375 billion riyals to development infrastructure (during most of this period the exchange rate was around 3.5 Rls to the U.S. dollar).

The purpose of the analysis below, therefore, is to assess the effectiveness country's infrastructure program has had on alleviating bottlenecks impeding the country's development. Has the Saudi Arabian government's strategy of infrastructure led investment been successful in reducing inflationary pressures and hence in creating an environment conducive to sustained expansion of the non-oil private sector economy? Or on the other hand has the government's massive investment in infrastructure simply created an additional demand for the kingdom's scarce domestic resources without providing the additional consumer goods (especially in the non-traded categories) needed to reduce inflationary pressures?

STRUCTURAL CHARATERISTICS

Saudi Arabia's geography has created the need for heavy investments in infrastructure, especially in transportation. The country is characterized by immense diversity and, until at least the period of the post - 1973/74 oil boom, was fragmented geographically and economically (2). In general, because of its relatively small population the kingdom suffers from small market size which denies many local producers the advantages of economies of scale

(2) An excellent recent survey of the Saudi Arabian economy is given in Ali D. Johany, Michael Berne and J. Wilson Mixon, 1986.

(Matwally, M.M., 1979).Historically, since producers were dispersed geographically, they suffered from relatively high transportation and communication costs which in turn severely limited the opportunities for domestic trade. These elements have all worked to reduce the private rate of return on many types of investment (Turner, L., and Bedore, J.M., 1979), thereby enhancing the potential for an active government role.

In addition, despite diversification the Kingdom has tended to depend to a large degree on oil products, and perhaps the pilgrimage, for foreign exchange earnings. As such, the country is highly vulnerable to the vagaries of external economic developments that, in turn, create the need for government intervention.

On the positive side, of course, the development of hydrocarbons has meant that the country has not had to deplete available resources which could have been diverted to capital formation to finance oil imports. In addition, the kingdom differs from most developing countries in that the economy is generally more open, so that *a priori* one would expect financial crowding out of private investment to be relatively less of a problem to the extent that domestic residents can have access to foreign financial markets when there is an excess demand for credit (3).

On the other hand, being open to the world economy subjects the Saudi economy to movements in world prices. Especially, during the 1970s world wide inflation made it extremely difficult for the Saudi authorities to eliminate domestic inflationary pressures (Looney, R.E. 1984).

It could also be argued that because of the small size of the country, the government is more able to dominate the economy and, thereby, total domestic capital formation. In fact, one striking pattern characterizing Saudi Arabia's development has been the rapid expansion of government expenditures (4). In particular, government investment as a percent of total investment increased from slightly under 7 percent in 1960 to 42.9 percent in 1965, 53.3 percent in 1970, and 72.6 percent in 1980. The public sector's share in invest-

(3) The workings of these financial flows have been extensively analyzed by Rodney Wilson, (1982a, 1982b, 1983, 1986).

(4) Unless otherwise indicated, all economic data are taken from Saudi Arabian Monetary Agency *Annual Report*, various issues. Nominal values are deflated with the non-oil price index (1970 = 1.00).

ment has declined somewhat to 54.2 percent due to the oil price declines. Similarly, public sector consumption increased from slightly over 20 percent of total consumption in 1960 to 36.5 percent in 1965, 46.9 percent in 1975 and 5O.4 percent in 1982. Again, this share fell slightly to 45.1 in 1985 due to the decline in oil revenues.

The net result is that the expenditures of the public sector have risen as a percent of total expenditures from around 20 percent in 1960 to slightly under 50 percent in 1985.

This growth in the government sector has apparently not been at the expense of the private sector with overall private sector investment expanding at slightly under 9.8 percent per annum over the 1965-85 period.

In general, therefore, despite the huge fall in receipts, overall government spending has declined by a fairly small amount since the early 1980s. Within the total, however, there has been a steady increase in current expenditure and a decrease in spending on new infrastructural projects. The main brunt of the post 1982 contraction has therefore fallen on construction contractors, and the problems they have felt have been fed through to importers and manufacturers of building materials and equipment and finally to all other sectors of the economy (Field, M., 1986).

THE ROLE OF INFRASTRUCTURE IN DEVELOPMENT

In addition to the Hirschman image of infrastructure's role in the development process, a broad spectrum of viewpoints exist, some of them diametrically opposed to one another. There is a consensus, however, as to the need for basic infrastructure facilities. Ultimately infrastructure must be a limiting factor without which no development process could take place even if other development-inducing factors were present. However opinions as to infrastructure's precise role in economic development beyond this point differ greatly.

Some economists like Glover and Simon (1975) take the view that the role of infrastructure is simply to relieve "tensions" generated by supply and demand patterns as well as bottleneck pressures. Another (smaller) group of economist lead by F. Voigt (1974) maintain that alterations in infrastructure exert a follow-on influence on regional macroeconomic and social processes. Thus autonomous or induced changes in the stock of infrastructure produce external effects in the area serviced (5).

The majority of economists seem to take a middle position between these two more or less diametrically opposed views. Some of them consider infrastructure to be a function of the level of socio-economic development; in other words, the more economically and socially backward a potential development region, the stronger the impulses emanating from improvements in the stock of infrastructure. Other feel that the reciprocal relationship between changes in infrastructure and socio-economic development is such that the problem of cause and effect is not open to solution.

However, most economists agree that if infrastructure investments, labor market planning and educational planning are unconnected, they are likely to yield conflicting results or, at any rate, outcomes that could eventually lead to undesirable situations.

IMPACT OF INCREASED INFRASTRUCTURE ON DOMESTIC INFLATION

Operationally, the impact of infrastructure on inflation in Saudi Arabia is modeled by a blending of the Hirschman/Voigt and Glover/Simon views of the impacts stemming from the infrastructure development process. If infrastructure plays a role similar to that invisaged by Hirschman and Voigt, we should expect to find the resulting potential increase in the rate of return on various commercial activities inducing the private sector to inflation in the short run, over time, this should result in a closing of the inflationary gap created by the infusion of purchasing power associated with the construction phase of the infrastructure expansion program.

On the other hand, if the Glover and Simon view of the role of infrastructure is more appropriate in explaining private sector behavior, we would expect the private sector's expectations of future government actions, including likely extensions of the country's infrastructure to play a predominant role in shaping its decisions to expand output and or investment. However, the new higher level of output may, depending on the way its financed, result in an over-expansion of the money supply neutralizing the longer run anti-inflation-

(5) An empirical identification of both the Hirschman/Voigt and Glover/Simon patterns is given in Robert Looney and P. Frederksen, 1981.

ary effect of the induced expansion of infrastructure.

In the model that follows attempts to incorporate the inflationary effects of infrastructure implicit in both the Hirschman/Voigt and Glover/Simon approaches.

OPERATIONAL DEFINITIONS

Much of the confusion as to the role of infrastructure in the development process stems from the fact that few countries have statistics as to the value and composition of their stock of infrastructure . Saudi Arabia is no exception. In particular, official Saudi data on government investment contains both infrastructural and non-infrastructural type expenditures. Conceivably the cost reducing effect of the infrastructure component of government investment could be offset by the (inflationary) crowding out of private sector activity stemming from the the non-infrastructural component. To avoid these potential problems it is necessary to separate out and estimate the independent effects of the different categories of public investment. Since the raw data itself does not allow these distinctions to be made, one way of getting around this problem is to develop alternative proxies for infrastructural and non-infrastructural components. The basic assumption underlying these proxies is that infrastructure investment is an ongoing process that moves slowly over time and cannot be changed very rapidly. The first of the two approaches takes the trend level of real public sector investment (GINPLT) as representing the longterm or infrastructural component and argues that this should have a positive effect on gross real private investment; deviations from the trend (GINPDLT) are assumed to represent non-infrastructural investment (6).

A final factor that needs to be taken into account is the potential problem of real or physical crowding out. It is a well-accepted proposition that in Saudi Arabia absorptive capacity has been a problem, particularly in the early oil boom years (Looney, R.E., 1982). By definition, public sector expenditure can result in crowding out if it utilizes physical and financial resources that would

(6) The trend in expenditures was estimated using a linear regression with time. Expected expenditures were calculated as

EXP (t) = a + b [XP (t - 1)].

with the parameters a and b estimated over the period 1960-1985.

otherwise go to the private sector. Furthermore, the financing of public sector investment, whether through taxes, issuance of debt or inflation will lower the resources available for the private sector and thus depress private investment activity. These effects should not be a major factor in Saudi Arabia, however, given the government's resource base, lack of debt and inflation. Operationally a negative sign on the non infrastructural term [GINP (t) - GINPLT (t)] depicted below as (GINPDLT) can be assumed to reflect crowding out of private sector investment due to excessive allocations to non-infrastructural uses.

A variant on this approach is to make a distinction between types of public investment on the basis of whether or not investment is expected. Again it is assumed that expected public investment, GINPE, reflects the allocations of public investment for infrastructure, while the effects of unanticipated investment (the difference between actual and expected levels of government investment (GINPELT)) may result in crowding out of private sector activity and hence increased inflationary pressures.

STRUCTURE OF THE MODEL

The model used to examine the differential impact of government expenditures on inflation in Saudi Arabia incorporates the considerations outlined above:

1. In particular the three proxies for infrastructure investment outlined were tested to determine if in fact the results obtained were sensitive to the manner in which infrastructural investment was defined.
2. The inflationary impact of non-infrastructural components of government investment was estimated by including a short run measure of transitory government investment (GEXPT). For the level of government investment GINP, this consisted of changes in real investment from one year to the next (DGINP); for trend in government investment, this consisted of each year's deviation from the trend; and for the expected level government investment this consisted of unexpected government (the difference between actual government investment, GINP and expected government investment GINPE). Expected government investment was estimated in the same manner as expected inflation.

3. The impact of world price movements on the Saudi Arabian price level was included to reduce any biases stemming from the period of world inflation occuring in the mid to late 1970s. Since Saudi Arabia does not publish figures on the price of imports, this variable was proxied by the International Monetary Fund's industrial countries' export price index. This index was lagged one year (INFWL) to allow changes in import prices to work themselves through the domestic cost structure.
4. Inflation is also assumed to be a function of inflationary expectations (NODFE). This factor was proxied by regressing the non-oil price deflater on its value in the previous year, and using each year's predicted value in the regression equation.
5. The potential impact of excess money balances on the non-oil price deflater was treated by including the money supply (M1) in the regression equation.
6. The reduction in inflationary pressures stemming from increased real supplies of goods and services was proxied by non-oil GDP (NOXNP).

For a basis of comparison, the inflationary impact of two other types of government expenditure, government consumption (GCNP) and military expenditures (GME), were also examined. Since these expenditures tend to create demand and not be supply augmenting, their values (and those of their transitory components) were assumed to be positive.

Finally, to test the generality of the model regressions were performed using both the non-oil GDP deflater (NODF) and the consumer price index (CPI) (7).

Summarizing the above in equation form (with expected signs):

INF = f[INFE (+), INFWL (+), M1 (+), NOXNP (-), GEXP (- +), GEXPT (+)]

where INF = the non - oil GDP deflater (and the consumer price index);

INFE = expected increase in the non-oil GDP deflater (and the consumer price index);

INFWL = export price index of the industrialized countries (lagged one year);

(7) Estimations were made using the Cochraine-Orcutt iterative estimation procedure. This procedure transforms the data (generating a variable RHO) to eliminate serial correlation. Details of this procedure are given in Robert Hall, 1985.

M1 = the money supply as defined by the International Monetary Fund;

GEXP = government expenditures.

Three types of government expenditures were examined:

GINP = government investment (mainly infrastructure)

GCNP = government consumption

GME = military expenditures.

If our assumptions concerning infrastructure are correct, we would expect the sign on infrastructure investment to be negative, whereas it is assumed that government consumption and military expenditure by contributing to demand but not supply would have a positive sign (or be statistically insignificant). To test the generality of our results, several different specifications of government investment were tested:

GINPLT = the linear trend in government investment

GINPE = the expected level of government investment

GINPDLT = deviations from the trend in government investment

DGINP = changes in government expenditure

GINPELT = unexpected changes in government expenditures [actual government investment minus the expected level of government investment]

Here the presumption is that the infrastructure component of government investment is reflected more accurately in GINPE and GINPLT than the simple aggregate level of investment (GINP). Similar constructions were tested for government consumption and military expenditures in an effort to net out transitory expenditures from the longer run component of expenditures. The presumption here being that transitory fluctuations in expenditures were more likely to be inflationary than the longer run stable trend in expenditures.

EMPIRICAL RESULTS

Impact of infrastructure on the non-oil price deflater:

$$
\begin{aligned}
(1)\ \mathrm{NODF} = {} & \underset{(7.64)}{0.83\ \mathrm{NODFE}} + \underset{(5.00)}{2.42\ \mathrm{INFWL}} + \underset{(0.56)}{0.005\ \mathrm{M1}} - \underset{(-0.90)}{0.01\ \mathrm{NOXNP}} \\
& - 0.06\ \mathrm{GINP} + 0.07\ \mathrm{DGINP} - 0.42\ \mathrm{RHO}
\end{aligned}
$$

(-2.73) (1.47) (-2.18)

$R^2 = 0.999$; $F = 3531.1$; $DW = 2.27$

(2) NODF = O.85 NODFE + 2.51 INFWL + 0.002 M1 - 0.13 NOXNP

(7.60) (5.11) (0.27) (-0.65)

- 0.07 GINPLT - 0.002 GINPDLT - O.42 RHO

(-2.56) (-0.04) (-2.18)

$R^2 = 0.999$; $F = 3380.2$; $DW = 2.25$

(3) NODF = 0.89 NODFE + 2.64 INFWL + 0.0003 M1 - 0.03 NOXNP

(8.89) (5.27) (0.03) (-1.50)

- 0.05 GINPE - 0.02 GINPELT - 0.33 RHO

(-2.05) (-0.34) (-1.65)

$R^2 - 0.999$; $F = 2770.5$; $DW = 2.13$

Impact of government consumption on the non-oil GDP deflater

(1') NODF = O.94 NODFE + 2.10 INFWL + 0.007 M1 -0.07 NOXNP

(24.87) (12.31) (-2.36) (-7.20)

+ 0.09 GCNP - 0.06 DGCNP - 0.82 RHO

(7.75) (-5.80) (-6.90)

$R^2 = 0.999$; $F = 17142.5$; $DW = 2.75$

(2') NODF = O.87 NODFE + 1.81 INFWL + 0.006 M1 - 0.10 NOXNP

(21.69) (12.79) (1.59) (-8.09)

+ 0.10 GCNPLT + 0.02 GCNPDLT - 0.81 RHO

(8.54) (1.67) (-6.70)

$R^2 = 0.999$; $F = 19191.1$; $DW = 2.19$

(3') NODF = 0.94 NODFE + 2.17 INFWL - 0.005 M1 - 0.09 NOXNP

(29.19) (14.26) (-2.03) (-8.74)

+ 0.10 GCNPE + 0.04 GCNPELT - 0.83 RHO

(9.42) (3.75) (-7.10)

$R^2 = 0.999$; $F = 22550.0$; $DW = 2.88$

Impact of military expenditures on the non-oil GDP deflater

(1") NODF = 0.83 NODFE + 2.05 INFWL - 0.002 M1 - 0.04 NOXNP

(12.00) (3.21) (-0.32) (-2.12)

+ 0.06 GME - 0.11 DGME - 0.32 RHO

(1.78) (-2.88) (-1.63)

$R^2 = 0.999$; $F = 3304.9$; $DW = 2.08$

(2") NODF = O.77 NODFE + 2.28 INFWL + 0.007 M1 - 0.06 NOXNP

(12.29) (top.98) (1.08) (-3.35)

+ 0.07 GMELT - 0.09 GMEDLT - 0.27 RHO

$$\begin{array}{ccc} (2.20) & (-2.36) & (-1.31) \end{array}$$
$R^2 = 0.999$; $F = 3993.9$; $DW = 2.07$

$$\text{(3'') } NODF = \underset{(9.44)}{0.81\ NODFE} + \underset{(2.65)}{2.02\ INFWL} - \underset{(-0.15)}{0.001\ M1} - \underset{(-1.12)}{0.02\ NOXNP}$$
$$+ \underset{(0.70)}{0.03\ GMEE} - \underset{(-0.79)}{0.04\ GMEELT} - \underset{(-0.75)}{0.16\ RHO}$$
$R^2 = 0.998$; $F = 1959.2$; $DW = 1.93$

Several interesting patterns appear in the results:

7. It is clear that infrastructure investment in Saudi Arabia has reduced inflationary pressures. This conclusion holds for all three measures of the infrastructure component of government investment.
8. The transitory (non-infrastructural) component of government investment does not appear to have contributed to inflationary pressures over the period examined (1960-85).
9. World inflation has been imported into Saudi Arabia, and has contributed significantly to increases in the non-oil GDP deflater.
10. Contrary to the situation found in many other countries, the money supply does not appear to have made an independent contribution to inflation.
11. Government consumption, however, appears to have made a major impact on the price level.
12. On the other hand, the inflationary impact of transitory government consumption appears to vary depending on how this variable is defined.
13. Military expenditures appear to have a slight inflationary impact, although the level of statistical significance is fairly low for this source of inflationary pressure.

The importance of the composition of government expenditures is also illustrated by the fact that the over-all level of government expenditures (GEP) in its various functional forms is not statistically significant in affecting the non-oil deflater:

$$\text{(1''') } NODF = \underset{(10.03)}{0.84\ NODFE} + \underset{(3.72)}{1.90\ INFWL} - \underset{(-1.01)}{0.008\ M1} - \underset{(-1.21)}{0.03\ NOXNP}$$
$$+ \underset{(1.21)}{0.03\ GEP} - \underset{(-1.35)}{0.03\ DGEP} - \underset{(-1.21)}{0.28\ RHO}$$
$R^2 = 0.999$; $F = 2226.2$; $DW = 1.78$

$$\text{(2''') } NODF = \underset{(10.81)}{0.82\ NODFE} + \underset{(3.72)}{1.80\ INFWL} - \underset{(-0.23)}{0.02\ M1} - \underset{(-1.88)}{0.05\ NOXNP}$$

$$+ 1.68\ GEPLT - 0.001\ GEPLDT - 0.33\ RHO$$
$$(1.68) \quad (-0.07) \quad (-1.65)$$
$$R^2 = 0.999;\ F = 2691.7;\ DW = 1.72$$

$$(3''')\ NODF = 0.84\ NODFE + 1.91\ INFWL - 0.008\ M1 - 0.02\ NOXNP$$
$$(9.88) \quad (3.68) \quad (-0.91) \quad (-1.03)$$
$$+ 0.003\ GEPE + 0.004\ GEPELT - 0.28\ RHO$$
$$(1.04) \quad (0.21) \quad (-1.35)$$
$$R^2 = 0.999;\ F = 2163.5;\ DW = 1.80$$

The results obtained using the consumer price index were very similar to those found for the non-oil GDP deflater, and hence do not appear to warrant further discussion.

One result obtained above that does warrant further discussion is the role played by real output increases (NOXNP). This variable is not significant in the regressions involving infrastructure. On the other hand this variable plays an important role in reducing inflationary pressures when included in the analysis of government consumption and military expenditures. Further analysis indicated that this result stemmed largely from the fact that infrastructure investment has a strong and positive impact on real non oil gdp (NOXNP) whereas government consumption and military expenditures do not (8).

Using a distributed lag formulation (9) for non-oil GDP, it was assumed that real private investment (PINP), and the trend in real government revenues (GRPLT) produce a positive impact. The impact of government expenditures was then introduced (10).

Operationally:

$$NOXNP = f[NOXNPL\ (+),\ PINP\ (+),\ GRPLT\ (+),\ GEXP\ (+)\ ]$$

where: NOXNP = real non oil GDP
PINP = real private investment
GRPLT = the trend in real government revenues
GEXP = the trend in real government expenditures

Impact of government investment on non -oil GDP

$$NOXNP = 0.67\ NOXNPL + 0.63\ PINP + 0.04\ GRPLT$$
$$(13.35) \quad (1.88) \quad (1.47)$$
$$+ 0.48\ GINPLT - 0.58\ RHO$$

(8) A discussion of distributed lags and their properties are contained in Rao P. and R. Miller, 1971.

(9) Operationally distributed lags are estimated by including the lagged value of the dependent variable (NOXNPL) as an independent regressor.

(10) To save space we present just the cases with the trend in government expenditures.

(5.00) (-3.38)

$R^2 = 0.998$; F = 2581.3; DW = 2.52

Impact of government consumption on non-oil GDP

NOXNP = 1.00 NOXNPL + 0.55 PINP + 0.11 GRPLT
(6.50) (1.05) (2.54)
- 0.37 GCNPLT - 0.31 RHO
(-1.35) (-1.57)

$R^2 = 0.995$; F = 908.2; DW - 2.01

Impact of military expenditures on non-oil GDP

NOXNP = 0.64 NOXNPL + 0.38 PINP - 0.006 GRPLT
(5.87) (0.72) (-0.10)
+ 0.61 GME - 0.24 RHO
(1.72) (-1.17)

$R^2 = 0.995$; F = 925.4; DW = 1.88

The timing of infrastructure's contribution to price stability is also of considerable interest i.e. how much time elapsed between the time the post 1973/74 investment boom and the point when infrastructure investment ceased to be inflationary and began to reduce over-all inflationary pressures?

Using the linear trend (GINPLT) as the measure of infrastructural investment, and starting with the 1960-75 time interval, this transition appears to have begun around 1979:

Impact of infrastructure on inflation, 1960 -1975

(a) NODF = 0.89 NODFE + 0.11 INFWL + 0.06 M1 - 0.05 NOXNP
(2.84) (0.12) (3.23) (-6.00)
+ 0.09 GINPLT - 0.12 RHO
(2.54) (-0.42)

$R^2 = 0.999$; F = 1183.1; DW = 2.14

Impact of infrastructure investment on inflation 1960-1976

(b) NODF = 0.31 NODFE + 1.26 INFWL + 0.06 M1 - 0.06 NOXNP
(2.46) (2.41) (3.60) (-6.70)
+ 0.12 GINPLT + 0.43 RHO
(3.31) (1.76)

$R^2 = 0.999$; F = 1918.0; DW = 1.66

Impact of infrastructure investment on inflation 1960-1977

(c) NODF = 0.83 NODFE + 3.46 INFWL - 0.01 M1 - 0.08 NOXNP
(8.09) (14.92) (-1.19) (-8.61)
+ 0.14 GINPLT - 0.48 RHO

(4.89) (-2.09)

$R^2 = 0.999$; F= 5240.1; DW = 2.43

Impact of infrastructure on inflation 1960-1978

(d) NODF = 0.74 NODFE + 3.26 INFWL - 0.002 M1 - 0.07 NOXNP
(11.21) (21.75) (-0.43) (-8.31)
+ 0.14 GINPLT - 0.44 RHO
(4.71) (-1.89)

$R^2 = 0.999$; F= 8865.0; DW = 2.43

Impact of infrastructure on inflation 1960-79

(e) NODF = 0.50 NODFE + 2.67 INFWL + 0.06 M1 - 0.08 NOXNP
(5.10) (9.14) (6.92) (-5.14)
- 0.15 GINPLT + 0.78 RHO
(-4.41) (5.01)

$R^2 = 0.999$; F= 498.9; DW = 2.23

Impact of infrastructure on inflation 1960-80

(f) NODF = 0.33 NODFE + 3.01 INFWL + 0.06 M1 - 0.05 NOXNP
(2.82) (8.33) (5.10) (-2.88)
-0.13 GINPLT + 0.62 RHO
(-2.88) (3.27)

$R^2 = 0.999$; F= 617.5; DW = 1.74

Impact of infrastructure on inflation 1960-81

(g) NODF = 1.03 NODFE + 3.08 INFWL - 0.02 M1 - 0.03 NOXNP
(7.99) (8.06) (-1.26) (-1.81)
-0.01 GINPLT - 0.62 RHO
(-0.26) (-3.41)

$R^2 = 0.999$; F= 3432.2; DW = 2.34

Impact of infrastructure on inflation 1960-82

(h) NODF = 0.92 NODFE + 2.86 INFWL - 0.006 M1 - 0.03 NOXNP
(16.06) (9.48) (-0.96) (-1.56)
- 0.05 GINPLT - 0.68 RHO
(-1.38) (-4.09)

$R^2 = 0.999$; F = 4655.5; DW = 2.24

Impact of infrastructure on inflation 1960-83

(i) NODF = 0.86 NODFE + 2.43 INFWL + 0.003 M1 - 0.04 NOXNP
(12.37) (7.39) (0.40) (-2.22)
-0.09 GINPLT - 0.47 RHO
(-2.22) (-2.42)

$$R^2 = 0.999;\ F = 3234.9;\ DW = 2.23$$

Impact of infrastructure on inflation 1960-84

$$\text{(j) } NODF = \underset{(12.97)}{0.85\ NODFE} + \underset{(8.55)}{2.47\ INFWL} + \underset{(0.40)}{0.003\ M1} - \underset{(-0.56)}{0.07\ NOXNP} - \underset{(-2.51)}{0.08\ GINPLT} - \underset{(-2.56)}{0.48\ RHO}$$

$$R^2 = 0.999;\ F = 4071.6;\ DW = 2.33$$

Impact of infrastructure on inflation 1960-85

$$\text{(k) } NODF = \underset{(12.62)}{0.84\ NODFE} + \underset{(8.40)}{2.48\ INFWL} + \underset{(0.36)}{0.003\ M1} - \underset{(-0.96)}{0.01\ NOXNP} - \underset{(-2.65)}{0.07\ GINPLT} - \underset{(2.17)}{0.42\ RHO}$$

$$R^2 = 0.999;\ F = 4322.5;\ DW = 2.26$$

CONCLUSIONS

It is fairly safe to conclude that the Saudi Arabian development strategy, based largely on the assumptions of a Hirschman type infrastructure led growth program, has been successful in achieving its main aims: achieving non-inflationary increases in non-oil income. This strategy began paying fairly high dividends around 1979, and has enabled the country to sustain fairly respectable growth rates even during the current period of slack oil revenues. Ultimately, however the results presented here raise more questions as to the wisdom of the country's development strategy than perhaps they answer.

It is not at all clear, for example, how long past infrastructure investments will be able to sustain the growth momentum built up in the late 1970s and early 1980s. Will new, albeit, smaller additions to the stock of infrastructure caused by depressed oil markets be sufficient to sustain growth? Or, on the other hand, irrespective of its extent will further additions to the stock of infrastructure continue to have the same productivity in contributing to growth and inflation reduction as past investments? Or has the country reached the point where diminishing returns to further increases to the stock of infrastructure have been reached? If this is the case, what other strategies are available to replace infrastructural investment as a source of non-inflationary growth? Clearly answers to these questions are necessary before any complete assessment of the wisdom of the country's post 1973 development experience can be made.